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Experience with Microturbines in Canada 2002/03

Rob Brandon P.Eng.

CANMET Energy Technology Centre

Ottawa

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What is CANMET and Why are we doing this kind of work?

- The CANMET Energy Technology Centre (CETC) is one of the Canadian Federal Government’s energy laboratories, located in Ottawa
- The power generation sector in Canada contributes 15% of Canada’s Greenhouse Gas emissions
- The use of combined heat and power in both large district energy systems and individual buildings is a significant way to reduce greenhouse gas emissions in urban areas
- Reduction in waste gas flaring has positive environmental benefits

CETC's Experience with Microturbines

- Initial experiments with Ontario Hydro with heat recovery.
- Tested early prototypes of heat recovery system from Unifin International with Honeywell 75 kW
- Assisted Mariah Energy Corporation in the prototype development of integrated heat recovery unit
- Testing 2nd generation prototype of Unifin heat recovery unit

CETC's CHP Program Vision

- To assist in the development of a packaged microturbine Combined Heat and Power unit that can be installed by a HVAC contractor with little or no consulting engineering requirement.

OR PUTTING IT ANOTHER WAY

- A commercial package boiler that produces electricity.

Prototype HX on Capstone 30 kW Dec 1998

Summer 1999

Honeywell 75 kW, Winnipeg

Honeywell 75 kW

June 2000 -Dec 2001 5400 hours

Cummins 60 kW
3600 hrs to date


Mariah 30 kW
Prototype
Mariah 30 kW
CHP Oil Fuel
Halifax
April 2001
- Jan 2002,
2700 hrs
New Coated Core
at 1800 Hrs
Mariah
60 kW
CHP
Montreal

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Summary of Experiences with Heat Recovery Systems

- Efficiency of any heat recovery system is a function of return water temperature
- Experience with Mariah units has been around 80 % overall efficiency with a return water temperature of 30 deg C (Halifax unit)
- Experience with Mariah 60 kW unit at Place des Arts,Montreal has also indicated high overall efficiency
- Experience with Unifin 2nd Generation heat recovery unit In Toronto has shown lower efficiency of 65-70%

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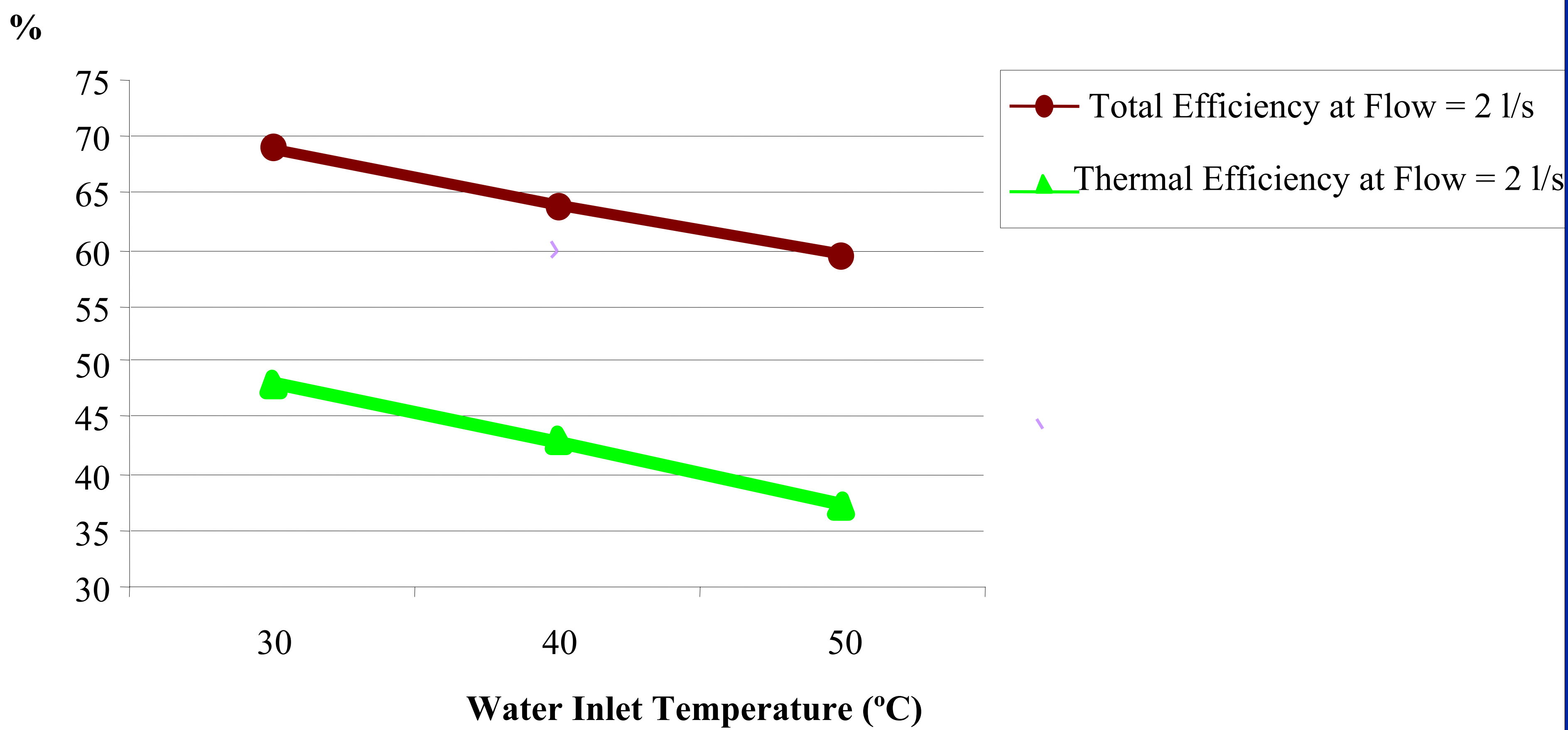
Variation in Thermal and Total Efficiency with Inlet Water Temperature Mariah 30 kW (original HX, oil fuel)



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Heat Recovery Experience

- Integral heat recovery systems are preferred as heat losses through interconnecting exhaust gas ductwork have been found to be significant
- In cold climates low inlet air temperatures will not increase power with inverter power systems. However lower turbine exhaust temperature reduces thermal output and thus reduces total efficiency
- If the unit is installed inside a boiler room there is a question as to whether the unit has increased the forced ventilation rate of the building and increased the building heat load, thus reducing gas savings

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Experience with acidic corrosion using oil fuel, Coated HRU appeared successful, more testing needed

Original Prototype HRU

Heresite Coated HRU

Note Alunogen buildup on fins (1800 hrs.)

Dual feed direction header with drain valve

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Mariah Experience to date

- Canadian Installations
  - Educational Institution, 2x30 kW units, 8200 hours
  - Apartment complex, 1x30 kW unit, 15,800 hours
  - Arena 2x30 kW unit,1800 hours
  - Greenhouse, 4x30 kW units,
  - Arts Complex 1x60 kW unit
- US Installations
  - Liquefied natural gas plant, 1x30 kW,space heating
  - Wastewater treatment plant, 1x 30 kW,process heat
  - Public housing building, 1x30 kW DHW
  - YMCA, 1x30 kW pool heating
  - Youth correctional facility,1x30 kW, DHW.

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Turbine Locational Issues

	In a Boiler Room	Outside on a pad
Noise	Not normally an issue	Can be an Issue
Intake air ducting	Using outside and inside air	Low CHP output in cold weather,low electrical output in hot weather
Exhaust ducting	Expensive,long ducts.	Simple
Thermal Connection	Easier	More difficult, need freeze protection
Electrical	Easier, transformer space an issue	Utility preferred
Cost	More expensive	
Maintenance		More difficult
Lifetime issues		Reduced life

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Waste Fuels

- Microturbines can use fuel with as lower methane content than reciprocating engines
- Low NOx very important in some areas
- Fuel waste compression and cleaning at reasonable cost remains an issue
- As natural gas increases in cost the economics of waste fuels improve relative to avoided power but conversely flare gas becomes more valuable and may be captured and processed

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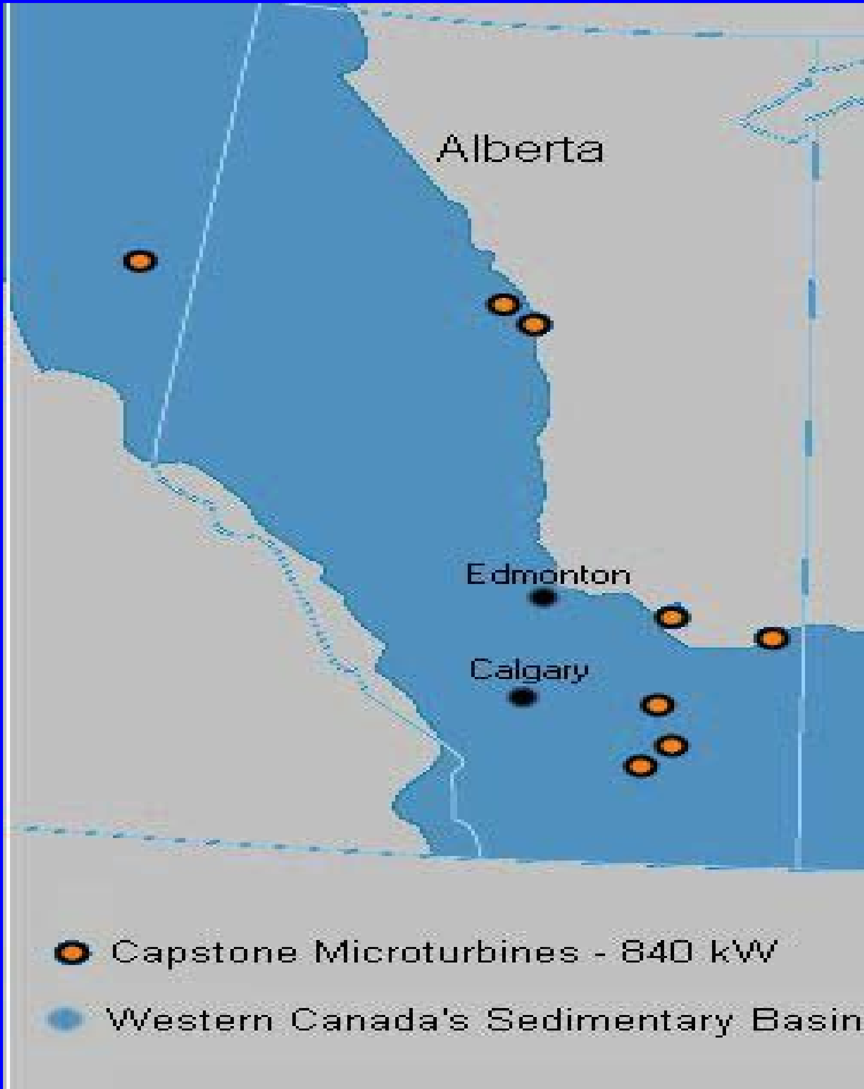
Microturbine Distribution

- There are currently 25 Capstone C30 Microturbines in Western Canada's Oil Fields.
- 20 of the 25 Microturbines are operating on a 24/7 basis.
- 3 Microturbines operate on standby and 2 have been decommissioned.



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Landfill Gas Microturbine
Calgary Alberta

- 30 kW Capstone and gas compressor and gas cooling system
- 1000 hrs of operation in 2002. Currently being rebuilt with heat recovery and DY thermally driven chilling system
- Project objective is to determine if chilling the LFG to condense water and contaminants will reduce overall cost of gas treatment system

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Microturbines in Greenhouses

- Morningside Rose Gardens, Alberta
- 4X70 kW Ingersoll Rand
- In operation over 02/03 Winter
- Turbines undergoing refurbishment by IR
- Future work will be to improve the heat recover efficiency and use exhaust gas directly in the greenhouses

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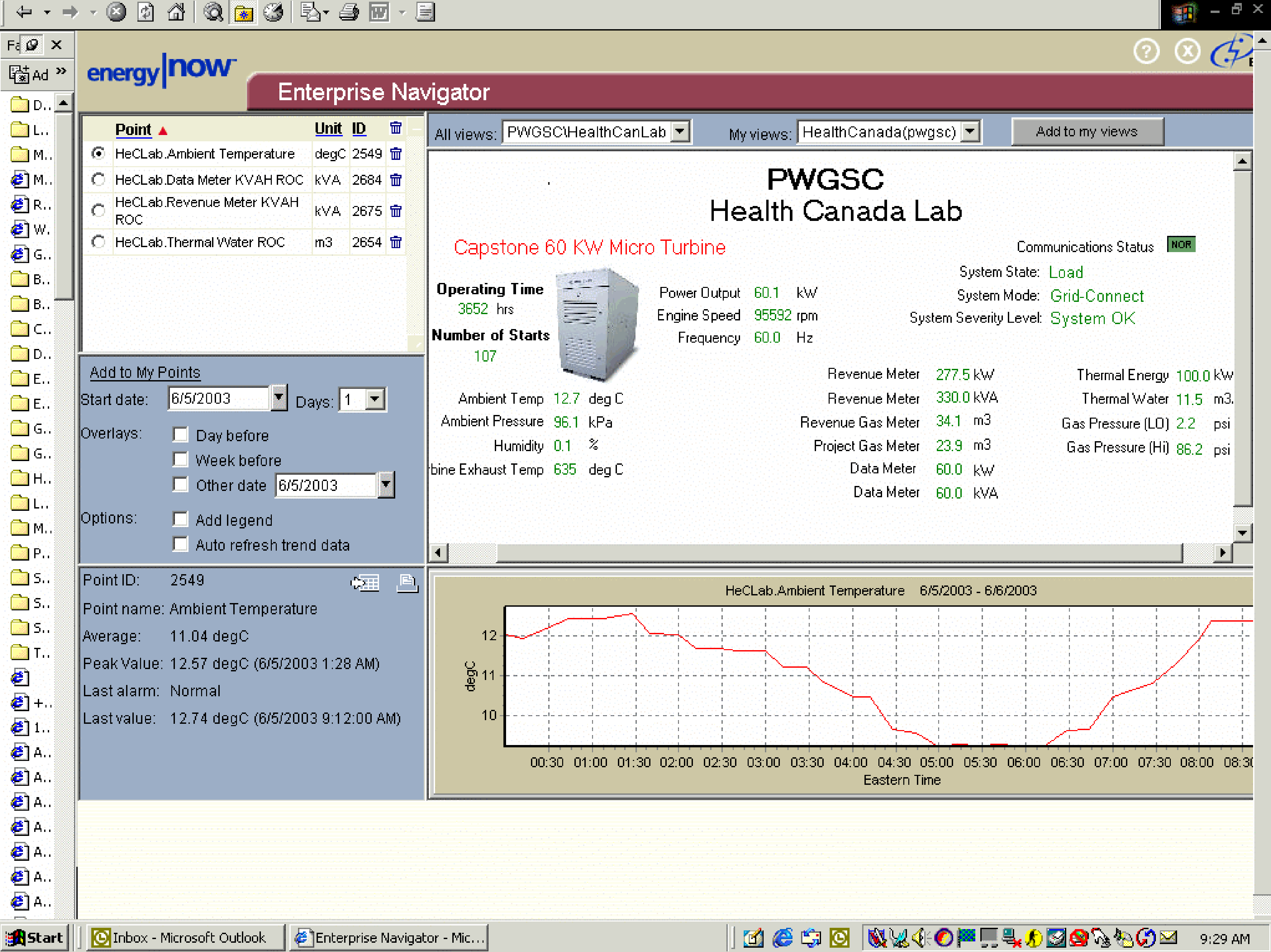
Cummins 60 kW Midland Rd Toronto

TB



energy now
Enterprise Navigator
Point
Unit
ID
HeCLab.Ambient Temperature degC 2549
HeCLab.Data Meter KVAH ROC kVA 2684
HeCLab.Revenue Meter KVAH ROC kVA 2675
HeCLab.Thermal Water ROC m3 2654
All views: PWGSC\HealthCanLab
My views: HealthCanada(pwgsc)
Add to my views
PWGSC
Health Canada Lab
Capstone 60 KW Micro Turbine
Communications Status NOR
System State: Load
System Mode: Grid-Connect
System Severity Level: System OK
Operating Time
3652 hrs
Number of Starts
107
Power Output 60.1 kW
Engine Speed 95592 rpm
Frequency 60.0 Hz
Revenue Meter 277.5 kW
Revenue Meter 330.0 kVA
Revenue Gas Meter 34.1 m3
Project Gas Meter 23.9 m3
Data Meter 60.0 kW
Data Meter 60.0 kVA
Thermal Energy 100.0 kW
Thermal Water 11.5 m3
Gas Pressure (LO) 2.2 psi
Gas Pressure (Hi) 86.2 psi
Ambient Temp 12.7 deg C
Ambient Pressure 96.1 kPa
Humidity 0.1 %
rbine Exhaust Temp 635 deg C
Add to My Points
Start date: 6/5/2003
Days: 1
Overlays:
Day before
Week before
Other date 6/5/2003
Options:
Add legend
Auto refresh trend data
Point ID: 2549
Point name: Ambient Temperature
Average: 11.04 degC
Peak Value: 12.57 degC (6/5/2003 1:28 AM)
Last alarm: Normal
Last value: 12.74 degC (6/5/2003 9:12:00 AM)
HeCLab.Ambient Temperature 6/5/2003 - 6/6/2003
degC
12
11
10
00:30 01:00 01:30 02:00 02:30 03:00 03:30 04:00 04:30 05:00 05:30 06:00 06:30 07:00 07:30 08:00
Eastern Time
Start
Inbox - Microsoft Outlook
Enterprise Navigator - Mic...
9:29 AM

Remote CHP Unit Dispatching

- Using DTE Energy site the microturbine is planned to be remotely dispatched on and off this summer
- Factors considering in dispatching algorithm are:
  - Pool Power Price
  - Site Electrical Demand
  - Site Thermal Demand
  - Gas Price (manual input)
- Turbine status is updated every 5 minutes based on real time information.
- Turbine is expected to be started up every morning and shut down at night during the summer and on continuously during the winter

R&D Focus
Thermally Activated Cooling

- Need to identify a cost effective way to use waste heat from micro turbines for cooling
- Also turbine power reduction during hot weather coincides with high power prices
- Small adsorption chillers have not proved to be that cost effective
- Development work ongoing with microturbine direct fired chillers (Broad, Carrier, Hitachi)
- CETC working on less efficient but hopefully lower cost cooling systems for small turbines

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Overall Objective

- To identify and help develop a thermally driven chiller system with the following characteristics.
  - Driven by hot water in the range 90-120 deg C
  - Has a minimum of pumps or moving parts, capable of 3 years between maintenance periods
  - Low capital cost
  - Can be located adjacent to cooling tower and not drained or thermally protected in freezing conditions
  - Use environmentally friendly refrigerants.

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Three Systems under consideration

- Jet Ejector
  - Uses a jet ejector to produce low pressure to generate chilling effect. Uses new non toxic, non flammable refrigerant.
- Ammonia Adsorption chiller
  - Uses hot water in the range 90-110 deg C to produce low temperature chilling of –8 deg C
  - Thermally pumped system
- Intake air supercharge with evaporative cooling
  - Inlet air pressurization combined with evaporative cooling

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Jet Pump Chiller Prototype

Ammonia Adsorption Chiller Prototype

Ingersoll Rand 70 kW CETC, Ottawa

Questions?